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RESEARCH PAPER

DETERMINATION OF SOME PHYSICO-CHEMICAL PARAMETERS OF DAN-ZARIA DAM IN NIGER STATE, NIGERIA.

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ABSTRACT

A study of some physico-chemical parameters assessment: Temperature, Conductivity, Dissolved Oxygen, Biochemical Oxygen Demand (BOD), Alkalinity, Hardness, Turbidity and pH of Dan-Zaria dam was conducted for 12 weeks (July-September, 2014). Five sampling stations were randomly located on the dam and bi-weekly replicated water samples were taken from each station during the period of study. Water samples taken from the field were analysed in the laboratory for the parameters indicated above except for temperature which was determined in the field. Data obtained from laboratory analysis were analysed using One-Way Analysis of Variance (One-Way ANOVA) and correlation statistical methods. Results showed that all the parameters determined were not significantly different ($p>0.05$). However, the mean values of temperature, pH, and conductivity fell within the recommended values for aquaculture while others did not. Based on these results, it was concluded that the water quality of Dan-Zaria dam during this period of study can only support certain fish species that can tolerate low dissolve oxygen.

KEYWORDS: Dan-Zaria dam, assessment, water quality, fish and optimum level.

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INTRODUCTION

Most biodiversity living species inhabit either partially or wholly aquatic environment. These organisms are closely related in environment through complex web or food chains in the

ecosystem. Water quality parameters provide important information about the health of water body (WHO, 2001). Water quality parameters are used to find out if the quality of the water is good enough for drinking, recreation, irrigation and aquatic life (APHA, 1998). The physico-chemical parameters of water include temperature, pH, Dissolve Oxygen (DO) Biochemical Oxygen Demand (BOD), conductivity, alkalinity, turbidity, ammonia, hardness, among others. The above mentioned parameters have effect on aquaculture and can be managed to improve on productivity of aquatic organisms. Temperature controls the rate of metabolic and reproductive activities. Most aquatic organisms are "cold blooded" which means they cannot control or regulate their own body temperature. Their body temperature becomes the temperature of the water around them (David *et al*. (1983). According to them cold blooded animals are adapted to a specific temperature range. If water temperature varies too much, metabolic activities can malfunction. All organisms including fish in water possess well defined limit of temperature tolerance with optimum lying between 22-32^{o}C in the tropics Boyd (1982). Dupree and Hurner (2000) recommended temperature of 25-32^{o}C for good performance of warm water fish. Ovie and Adeniji (1994) stated that in large water bodies such as seas and oceans temperature changes and its effects are as a result of light penetration, action and sediment particles which reduce the temperature of water and dissolve oxygen.

The pH of natural water can be made acidic or basic by human activities such as drainage and emissions from coal-burning power plant and heavy automobile traffic David *et al*. (1983). Boyd and Lichticoppler (1982) reported pH between 6.7-8.6 as the best to keep and maintain a good fish population in water. Ovie and Adeniji (1994) stated that pond water with high pH greater than 10 or pH less than 4 cannot support fish culture at all. Dupree and Humer (2000) reported that high pH is known to increase the toxicity of ammonia while low pH increases the toxicity of sulphide and cyanides. Dissolved oxygen (DO) is a very important indicator of water body's ability to support aquatic life. Fish breathe by absorbing DO through their gills (Boyd, 1982). The amount of DO in water depends on several factors such as temperature, the volume and velocity of water flowing in the water body and amount of organisms using oxygen for respiration. Human activities that affects DO level include run off from roads,

farms and sewage discharge (Hynes, 1970). The over fertilization of pond with organic and inorganic fertilizer could result in decomposition of excess fertilizers and production of poisonous gases such as H_2S and NH_3 among others. The increase of concentration of these gases will reduce the DO content of the medium (Kolo and Oladimeji, 2004). This retards the growth of fish. The electrolytic conductivity of water body refers to its ability to carry an electric current which in turn is related to total concentration of ion. The amount of dissolve ionisable salt in fresh water is generally considered to be related to potential biological productivity. (Hydrian, 1985). Increase in temperature has been found to cause increase in conductivity (Vincent *et al*., 1986). Conductivity is temperature dependent (Ejike, 1985). Flooding and decomposition of drowned material have a decrease effect in conductivity (Ovie and Adeniji, 1994). Alkalinity compounds such as carbonates, bicarbonates and hydroxides are natural buffers that remove excess hydrogen ion that have been added from sources such as acid rain or acid mine drainage. Carbonate, phosphorus and hydroxides increase alkalinity in natural water (EPA, 1986). Turbidity is a measure of the cloudiness of water. Turbidity in water is caused by suspended matter such as clay, silt and organic matter, soil erosion, urban runoff and high flow rate and plankton and other microscopic organisms that interfere with the passage of light through the water (Rai and Hill, 1981). Higher turbidity in water provides a medium for microbial growth (Hidetoshi *et al*., 2000). Turbidity of water has effect on rate of respiration on fish as it clogs and damages the gill of fish, exposure of eggs, larvae of benthic organisms and prevents light penetration. In view of the importance of water quality to aquatic organisms particularly fish, this study was conducted to determine the water quality status of Dan-Zaria dam; some physico-chemical parameters of the dam and establish whether these parameters fall within the recommended range that would support fish culture and other aquatic organisms.

MATERIALS AND METHOD

Study Area

The study was conducted at Dan-Zaria dam for 12 weeks (July-September, 2014). The dam was impounded in 1981 for animal water supply need. The dam is located at Federal University of Technology, Minna, Gidan Kwano Campus, along Minna-Bida Road, kilometre

3, from the Campus. It is a small water body with mean depth 3.1 m which source is mainly from upland run off. Five sampling stations (Station 1, 2, 3, 4 and 5) were randomly located on the dam and water samples were collected from each station bi-weekly and taken to the laboratory for analysis to determine water quality of some physico-chemical parameters of the water except for temperature which was determined at the field. The air and water temperatures were determined with a common mercury – in bulb thermometer (-10-110^{o}C) range). Air temperature was measured by holding the thermometer above the water surface for about 5 minutes until it stabilizes before taking the reading. Water temperature was determined by lowering the thermometer into the water in an inclined position for about 5 minutes to allow for equilibrium before taking reading.

Sampling Procedure and Laboratory Analysis

Determination of Dissolved Oxygen (DO)

DO was determined by Winkler-azide method as described by Golterman *et al*. (1978). DO is expressed in mg/l.

Determination of Hydrogen Ion Concentration (pH)

The pH was determined using KENT EIL pH model 7045/46 according to the method described by Lind (1979).

Determination of Electrical Conductivity

This was determined with conductivity meter using model JENWAY 4010 according to the method described by Lind (1979). The reading was expressed in micro-ohms/cm.

Determination of Total Hardness

This was determined by adding 1 ml of Ammonium buffer solution to 50 ml of water sample and followed by addition of 3 drops of Eriochrome black-T indicator. The resultant wine colour was titrated with 0.01N EDTA (ethylene-diamine-tetraacetic acid) titrant until a blue end point was observed.

Total hardness in mg/l as $CaCo_3$= $\frac{\text{vol. EDTA x N x100 x 1000}}{\text{Vol. of sample}}$

N = Normality of acid

Determination of Alkalinity (methyl orange)

The alkalinity of the sample was determined by taken 50 ml of water sample into a clean conical flask and 2 drops of methyl orange was added as indicator and shaken. This was titrated with 0.02N Sulphuric acid until the colour of the solution changed from yellow to orange which marks the end point. The total alkalinity was calculated using the formulae below:

Total alkalinity in mg/l= $\frac{\text{Vol. } (H_2S0_4) \text{ x molarity } (H_2S0_4)}{\text{Vol. of sample}}$ x 1000

Determination of Turbidity

This was determined by gently agitating water sample and wait until air bubbles disappear after which the sample was poured into cell. The reading was then taken directly from calibrated nephelometer.

Determination of Biochemical Oxygen Demand (BOD)

This was determined by determining the DO of the water sample on the first day and second BOD bottle was incubated at room temperature for 5 days in the dark before the titration for oxygen using Winkler-azides method.

BOD (mg/l) = Dissolved Oxygen on day 1-Dissolved Oxygen on day 5.

Statistical Analysis

One- way Analysis of Variance (ANOVA) was used for statistical analysis and Special Package for Social Sciences (SPSS) was used as statistical package for the analysis.

Correlation statistical methods was also used to determine correlation between parameters at P= 0.05 and 0.01 level of significance.

RESULTS

The result of mean value physico-chemical parameters at five different stations of Dan-Zaria Dam in Table 1 shows that the mean value for temperature in station 3 had the highest value though not significantly different ($p>0.05$) as compared to other stations. Generally, for all the water quality parameters determined during the study period there was no significant difference ($p>0.05$) among them. The result of correlation matrix of some physico-chemical parameters of Dan-Zaria dam in Table 2 shows that correlation between temperature and pH was positive but not significant. Correlation between temperature and conductivity was positive and significant. However, the correlation between temperature and DO and temperature and BOD was negative and not significant but correlation between temperature and alkalinity was positive and highly significant. Positive and negative correlations were observed in other parameters measured, some were not significant, some significant while others were highly significant.

Table 1: Mean Value Physico-chemical Parameters of Dan-Zaria Dam (July-September, 2014) for 12 Weeks.

	STATIONS				
PARAMETERS	1	2	3	4	5
Temp. (^oC)	22.60±1.06[a]	23.30±0.80[a]	23.50±092[a]	22.80±0.65[a]	23.10±0.60[a]
pH	6.88±0.20[a]	6.80±0.13[a]	6.76±0.31[a]	6.91±0.91[a]	6.84±0.10[a]
Cond. (µs/cm)	205.50±142.07[a]	202.60±144.18[a]	205.90±143.64[a]	201.10±144.85[a]	204.10±145.82[a]
DO (mg/l)	3.00±1.09[a]	3.60±1.75[a]	3.20±1.25[a]	3.50±1.66[a]	3.60±1.51[a]
BOD (mg/l)	0.64±0.40[a]	0.89±0.62[a]	0.58±0.47[a]	0.81±0.68[a]	0.76±0.62[a]
Hardness (mg/l)	40.90±19.60[a]	45.90±28.40[a]	45.40±24.30[a]	42.10±19.20[a]	45.40±24.10[a]
Alkalinity (mg/l)	2.33±1.05[a]	2.41±1.06[a]	2.45±2.45[a]	2.46±1.01[a]	2.44±1.02[a]
Turbidity (ppm)	0.24±0.22[a]	0.46±0.62[a]	0.65±0.76[a]	0.60±0.63[a]	0.60±0.65[a]

Mean values on the same column carrying the same superscripts did not differed significantly ($p>0.05$) from each other.

Key: Temp. = Temperature, Cond.= Conductivity, DO= Dissolved Oxygen and BOD = Biochemical Oxygen Demand.

Table 2: Correlation Matrix of Physico-chemical Parameters of Dan-Zaria Dam (July-September, 2014) for 12 Weeks.

PARAMETERS	Temp.(^{o}C)	pH	Cond.(µs/cm)	DO (mg/l)	BOD (mg/l)	Hardness (mg/l)	Alkalinity (mg/l)	Turbidity (ppm)
Temp. (^{o}C)	1							
pH	0.040	1						
Cond. (µs/cm)	0.314*	0.358*	1					
DO (mg/l)	-0.238	-0.433**	-0.702**	1				
BOD (mg/l)	-0.311	-0.299	-0.590**	0.906**	1			
Hardness (mg/l)	0.267	0.301	0.976**	-0.692**	-0.581**	1		
Alkalinity (mg/l)	0.409**	0.367**	0.766**	-0.634**	-0.541**	0.762**	1	
Turbidity (ppm)	-0.062	0.361*	0.482**	-0.580**	-0.530**	0.497**	0.192	1

*Correlation is significant at 0.05 level **Correlation is significant at 0.01 level

DISCUSSION

Mean values obtained for water quality parameters for (Temperature, pH and conductivity) for the period of study were within the tolerance range of warm water fishes. This corroborates the findings of Ofojekwu (1990) who reported that fish are able to survive in water with pH range of 3.5-10.00 but the desirable range for good growth is from 6.5-9.00. The result also corroborates the observations of Chervinski (1982) and Pandey (2004) that pH range 6.5-9.5 is suitable for fish growth and production. The temperature range (22.60-23.50^{o}C) obtained in this study is similar to the report of Ayinla (2002) who recommended 22-30^{o}C for fish larval rearing. Dissolved oxygen pattern corroborates the report of Adekoya (2004) that dissolved oxygen less than 3ppm causes discomfort to fish and lead to death. All the values obtained for DO (3.00-3.60 mg/l) fell short of desirable range of DO for warm water fishes as Ofojekwu (1990) recommended 5.5-7.8 mg/l for tropical fishes. The low values of DO obtained in this study might be attributed to lentic nature of the water as similarly reported by Kolo and Oladimeji (2004) that DO is progressively low in stagnant water. The high values of conductivity obtained in all the stations could be due to dissolve substances as a result of human activities such as farming around the dam and heavy runoff from up land into the dam as similar observation was made by Kolo and Oladimeji (2004). The mean low value of BOD obtained at all stations could be as a result of oxygen usage in the water. On the contrary, Kolo and Oladimeji (2004) obtained high mean values of BOD during the dry season on Shiroro Lake and attributed low organic content to it. The low value of alkalinity obtained was due to lack of limestone (carbonate of Magnesium and Calcium) deposit in the surrounding soil that is close to the dam which led to very low buffering capacity as similarly reported by Ejike (1985). The water turbidity obtained in this study falls below the recommended range of 7.2-10 ppm as reported by Boyd and Lichticoppler (1982). Ejike (1985) also reported that water turbidity below 4.5 ppm or above 10 ppm will affect adversely the survival and growth of fish. There was accumulation of suspended solid

particles on the dam due to high rate of flood water, surface runoff and unsettled effect of suspended particles after intense rains.

CONCLUSION

Based on this study, it could be concluded that the water quality of Dan-Zaria dam during this period of study can only support certain fish species that can tolerate low dissolved oxygen.

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